

Synchronizing to film and video

SO-04-0790

Time code synchronization

You can synchronize any Direct-to-Disk recording, or play back a sequence locked to film or video using time code.

SMPTE time code

SMPTE* time code is a digital sync signal on tape that keeps track of elapsed time with a 24-hour clock. SMPTE allows you to locate any event in a sequence and play back or record in sync from that point.

In video productions, the time code is recorded onto the audio or cue track. When the original material is dubbed onto a work tape, a time code display is burned in over the picture. The display can be read easily at slow shuttle speeds for quickly and accurately finding a specific frame. In post-production editing, the time code is used to make an edit decision list, which is then programmed into a computer editing system.

Audio recording studios use time code as an accurate tape locator and as a sync reference for such applications as auto-mix, sync-to-film or synchronization to computer-based instruments like the Synclavier. Time code is also used to synchronize multiple recording machines, allowing them to act as a single machine with multiple audio channels.

To synchronize music, dialog or sound effects with film or video, you just match the time code of the picture with that of the audio.

* SMPTE stands for the Society of Motion Picture and Television Engineers.

For further information on SMPTE time code, see Walter A. Hickman, *Time Code Handbook*, Cipher Digital, Inc. 1987.

4.2 Studio operations

SMPTE time display

SMPTE time code is expressed in terms of an eight-digit number (hours : minutes : seconds : frames). Each frame is further divided into 80 equal bits of a frame. This number serves as a point of reference for locating a particular event in time. An event occurring at

01:29:14:09.51

would start at 1 hour, 29 minutes, 14 seconds, 9 frames plus 51 frame bits after the beginning of the time code. The time code advances by frames. When the frame bits column reaches 79, the frames column advances by one. As the frames column reaches its upper limit, the seconds column advances, and so forth.

A portion of the digital signal is reserved for user information, such as reel numbers, location codes, take IDs or dates. The Direct-to-Disk acknowledges these codes, but it does not make use of them and they do not appear in the time code address.

Time code synchronization (con't)

Time code formats

The video and film industries use four time code formats which can be read by the SMPTE option. Each format can be recorded on audio tape and is used for synchronization to a different type of visual medium. Each format measures elapsed time in frames per second (fps).

- **Non-drop SMPTE (30 fps).** American black-and-white video uses a frame rate of 30 fps. The SMPTE frames column counts 30 frames, after which the seconds column advances and the frames column returns to zero.
- **Drop-frame SMPTE.** American color video uses a frame rate of approximately 29.97 fps. To compensate for the .03 fps (108 frames or 3.6 seconds per hour) less than the black-and-white signal, the frames column counts 30 fps and then compensates for the additional frames by dropping frames in a regular pattern. The other columns advance in the same manner as Non-drop SMPTE.
- **25-frame SMPTE (25 fps).** European video uses a frame rate of 25 fps. The SMPTE frames column counts 25 frames before advancing the seconds column and returning to zero.
- **24-frame SMPTE (24 fps).** The film industry uses a frame rate of 24 fps. The SMPTE frames column counts 24 frames before advancing the seconds column and returning to zero.
- **30-frame NTSC SMPTE.** CMX lists which contain both drop-frame and non-drop frame source material can be conformed using the NTSC format.

4.4 Studio operations

SMPTE offset

A film may contain many sequences starting at different times. A sequence that is a score may begin two minutes into the film, whereas, a sequence of effects may begin two hours into the film. Different sequences may be triggered throughout the film.

The SMPTE offset is the SMPTE time at which the sequence begins. If the sequence begins at 00:00:00:00, then there is no SMPTE offset.

The SMPTE offset time can be set from the Sequence Editor, the Audio Event Editor or the keyboard control panel, and is saved with the sequence.

Display offset

The display offset is used to display a different number than is entering the system. It can be used any time you want to change the time and format of the time code currently displayed.

If, for instance, your sequence starts at an odd time code number, like 02:13:54:23, you can choose to display this time as 01:00:00:00, a much easier number to read. This is similar to setting a mark point on a tape machine and then zeroing the tape counter at this point.

You can also fix a discrepancy in the time code displayed. Occasionally, the time code displayed is different from what is shown in the time code window on the videotape. In this case, you can fix the displayed time so that it is the same as that on the video image.

The display offset can also be used to set a relationship between Feet:Frames and SMPTE. You merely set the point at which you want a video location in Feet:Frames to display a particular SMPTE time.

The display offset is saved with the sequence. When you recall the sequence, the display offset is recalled automatically.

Time code synchronization (con't)

Receiving and generating SMPTE time code

Whenever recorded SMPTE time code is fed into the SMPTE IN jack and the SMPTE option is turned on, the sequence does not automatically play when START or RECORD is pressed. Instead, it waits for incoming time code to trigger it at the SMPTE offset time.

If the incoming time code starts before the start of the sequence, the sequence waits for the SMPTE offset time before beginning. If the incoming time code starts after the start of the sequence, the sequence automatically advances to the correct time. Each time SMPTE is stopped, fast forwarded or rewound, the sequence automatically synchronizes to the correct SMPTE frame. If the SMPTE tape has been wound a long distance, there may be some lag time before the sequencer catches up.

The system can read SMPTE signals at rates as slow as approximately one frame per second. Thus, operations such as slow-motion video cue spotting are easily accomplished.

The system can also generate time code in all four SMPTE formats. (Generating time code is explained in more detail in "Generating SMPTE time code.")

Except for START and RECORD, all motion control buttons are inactive during SMPTE operations. The MARK button is also inactive, although mark points remain in memory.

Storing SMPTE parameters

When you store a sequence, the selected SMPTE mode and offset are stored with the sequence.

If you recall a sequence with SMPTE information and change the SMPTE mode or the offset, you must store the sequence again in order to store the new SMPTE information.

Vertical Interval Time Code (VITC)

Vertical Interval Time Code (VITC) contains the same address and user information as SMPTE time code. But whereas SMPTE is usually striped onto a separate audio track, VITC is recorded within the video signal on tape. The biggest advantage to VITC is that, unlike SMPTE, it can be read at slow and still-frame speeds.

Systems which contain the VITC option can accurately track the output of VITC readers, tach-to-time code converters, shaft encoders and other devices which can receive a signal and convert it to longitudinal time code.

This longitudinal time code is fed into the SMPTE IN jack on the control unit. When still-framing, a signal which repeats the same frame address is sent to the system in order to accurately read the time code.

Setting time code parameters from the Sequence Editor

You can set the time display to SMPTE and select the mode for incoming time code from the Sequence Editor Display.

Setting the time display to SMPTE

The current time of the sequence appears at the upper right corner of the Sequence Editor. This time display is set by default to beats and measures. All other times that appear on the Sequence Editor are shown in the same format as the time display.

You can change the display to SMPTE.

- 1. Select the Sequence Editor from the Main Menu.

The Sequence Editor Display appears. The current time display of the sequence appears in the upper right corner as well as in all time fields in the Locator panel.

- 2. Step the time display switch in the Locator panel (set by default to Beats:Meas) to SMPTE.

All time displays change to SMPTE time code.

The Locator panel on the Sequence Editor Display

<input checked="" type="checkbox"/> Edit Start : 00:00:00:00.00	Click: ON	Jus: OFF	SMPTE					
<input checked="" type="checkbox"/> Edit End : 00:00:00:00.00	<input checked="" type="checkbox"/> Mark: ON		00:00:00:00.00					
<input checked="" type="checkbox"/> Edit Length : 00:00:00:00.00	M1	M2	M3	M4	M5	M6	M7	M8

Preparing to receive SMPTE time code

When triggering the sequence with incoming SMPTE time code, the sync mode must be set to SMPTE and the incoming time code format selected.

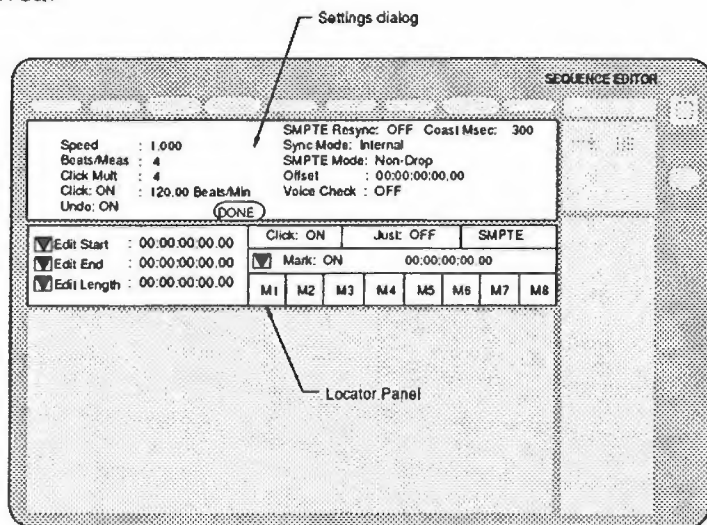
1. Click the Settings command in the Command panel.

The Settings dialog appears in the Dialog panel with the Sync mode set to Internal.

2. Set the Sync mode switch to SMPTE.
3. Step the SMPTE mode field to the desired SMPTE mode (Non-drop, Drop-frame, 25-frame or 24-frame).

All incoming time code is read in the selected format. If the system receives a signal that does not match the mode selected, an error message appears.

When you have finished synchronizing the sequence, be sure you set the Sync mode switch back to Internal. Whenever the Sync mode is set to SMPTE, the sequence will not start until incoming time code is received.



Settings dialog

***Setting time code
parameters from
the Sequence
Editor (con't)***

SMPTE resync and coast

When a SMPTE signal is lost temporarily, the Synclavier calculates a speed from the last signals received and continues or "coasts" until valid SMPTE signals are again received. The length of time that the Synclavier will do this can be set from 0 to 5000 ms. You adjust this parameter by setting the Coast Msec: number field on the Sequence Editor Settings dialog.

After a loss of SMPTE signal, the Synclavier may be slightly off from the SMPTE time code. You can either set it to resynchronize, which may result in a slight interruption in the sequence; or you can set it to continue slightly off and preserve the integrity of the sequence,. You do this by setting the SMPTE Resync: switch on the Sequence Editor Settings dialog to ON or OFF.

Setting a SMPTE offset

As explained earlier, the SMPTE offset is the SMPTE time at which the sequence starts.

To assure precise synchronization of the first click of the sequence, there should be a pre-roll SMPTE signal of at least one second before the SMPTE start time used for playback. For example, if the SMPTE signal recorded on tape starts at 01:00:00:00.00, the starting time for playback of the sequence should be at least 01:00:01:00.00.

You set the SMPTE offset from the Settings dialog in the Dialog panel.

1. Click on the Offset field.
2. Enter the desired SMPTE offset time.

Setting time code parameters from the Audio Event Editor

When triggering audio from the Direct-to-Disk tracks with incoming time code, the sync mode must be set to SMPTE.

Preparing to receive time code

You select the mode for incoming time code from the Audio Event Editor.

1. Step the Synchronization switch on the left side of the Synchronization and Time Control panel to SMPTE.
2. Step the Display Time switch at the top of the panel to the format in which you want the times displayed.
3. Select the desired mode for the incoming time code by clicking the appropriate box on the right side of the panel (Drop-frame, 30-frame, 25-frame or 24-frame).

Once the parameters are set, all incoming time code is read in the selected format. If the system receives a signal that does not match the mode selected, an error message appears.

You can also turn SMPTE on from the Selection panel.

- Click the ON button above the large time display in the Selection panel.

The ON button lights, and the system is ready to accept incoming time code.

When you have finished synchronizing the sequence or tracks, be sure you turn off the SMPTE option. Whenever SMPTE is on, the audio recorded on the Direct-to-Disk will not play until incoming time code is received.

Setting a SMPTE offset

A SMPTE offset is the SMPTE time at which you want your sequence to start.

To assure precise synchronization of the first click of the sequence, there should be a pre-roll SMPTE signal of at least one second before the SMPTE starting time used for playback. For example, if the SMPTE signal recorded on tape starts at 01:00:00:00.00, the starting time for playback of the sequence should be at least 01:00:01:00.00.

You set the SMPTE offset from the Synchronization and Time Control panel of the Audio Event Editor.

1. Click the SMPTE OFFSET field at the top of the panel.
2. Enter the desired SMPTE offset time and press Return.

You can use the SMPTE offset Take button to take the offset time while the sequence is playing.

You can also set SMPTE from the Selection panel.

1. Click the SET SMPTE button above the time display in the Selection panel.

The following dialog appears.

Enter the Sequencer SMPTE Offset 00:00:00:00 [DONE]

2. Type in or use the Take button to enter a SMPTE offset time.
3. When you are finished, click [DONE].

Setting time code parameters from the Audio Event Editor (con't)

Computing a SMPTE offset

You can sync any sequence time to any SMPTE time and automatically calculate the new SMPTE offset required to trigger the sequence. This feature is useful for such things as backtiming.

1. Click the COMPUTE SMPTE OFFSET button at the bottom of the Synchronization and Time Control panel.

A dialog box appears at the bottom of the panel.

2. Select the DISPLAY TIME IN format at the top left of the panel.

The SEQUENCE TIME field in the dialog box changes to the selected time format.

3. Enter into the SEQUENCE TIME field the time you want to sync to by typing it or by using the Take button.
4. Enter the SMPTE time to which the sequence time is synced into the SYNC TO SMPTE TIME field by typing it or by using the Take button.
5. Click the COMPUTE SMPTE OFFSET button in the dialog to compute the new SMPTE offset time.

The new SMPTE offset appears at the top of the panel. This is the SMPTE time at which the sequence is triggered.

6. When you are finished, click DONE at the end of the dialog.

Setting the display offset

Set the display offset from the Synchronization and Time Control panel.

1. Click the SET DISLAY OFFSET button at the bottom of the panel.

A dialog box appears at the bottom of the panel.

2. Select the DISPLAY TIME IN format at the top left of the panel.

The DISPLAYS field below in the dialog box changes to either SMPTE or Feet:Frames depending on the selection you make.

3. Enter the current SMPTE time into the SMPTE TIME field by typing it or by using the Take button.
4. Enter the time you want displayed into the DISPLAYS time field.

The SMPTE OFFSET button reflects the amount of the display offset. The button lights when a SMPTE display offset is turned on. It does not light or show a box when there is a footage offset.

5. If you want to change the film format or frame rate, click the button next to the DISPLAYS time field that corresponds to the rate and format in which the time should be displayed.

Note: The display offset is not calculated if you only enter a number into the SMPTE TIME field. You must also enter a number in the DISPLAYS time in order for the display offset to be calculated.

Turning the display offset on and off

You can view SMPTE times with or without the display offset included by clicking the SMPTE OFFSET button at the top of the Synchronization and Time Control panel. Setting a footage offset does not affect the SMPTE OFFSET button in any way.

SMPTE OFFSET button

status	meaning
Boxed	A SMPTE display offset has been set.
Unboxed	No SMPTE display offset has been set.
Highlighted	The SMPTE display offset is turned on. Times include the amount of the display offset.

Computing equivalent times

Given a time, you can compute its equivalent in any of the available time formats. For example, if you know the SMPTE time at which a cue occurs, you can calculate the equivalent start time in Measures:Beats, or vice versa.

This function does not affect any other time field. It is used only as a calculator on the Synchronization and Time Control panel.

1. Click the COMPUTE EVENT TIME button at the bottom of the panel.

A dialog appears at the bottom of the panel.

2. Toggle the first time field to the appropriate format.
3. Enter the time that you want to find the equivalent for into the first time field by typing it or by using the Take button.
4. Toggle the second time field to a different time format.

The equivalent times in the selected formats are shown.

5. When you are finished, click DONE at the end of the dialog.

The dialog disappears.

You can enter a time into either time field and its equivalent is calculated in the opposite field.

Setting a SMPTE offset

The SMPTE offset is the SMPTE at which you want the sequence to start.

To assure precise synchronization of the first click of the sequence, there should be a pre-roll SMPTE signal for at least one second before the SMPTE starting time used for playback. For example, if the SMPTE signal recorded on tape starts at 01:00:00:00.00, the offset time for playback of the sequence should be at least 01:00:01:00.00.

You can set the offset time increasing by frame bits.

- With SMPTE activated, turn the control knob.

The time increases by frame bits.

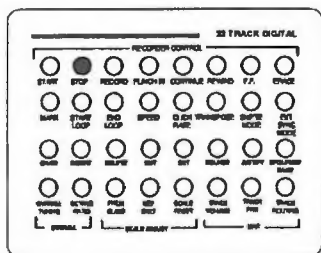
You can set the offset time increasing by whole seconds.

1. Press and hold the SMPTE MODE button.
2. Turn the control knob.

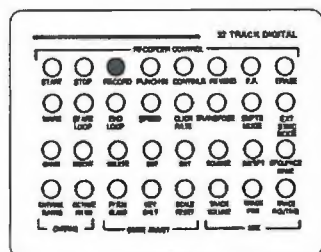
The time advances by whole seconds.

Recording with SMPTE

Once SMPTE parameters are set, you synchronize the current sequence or Direct-to-Disk tracks to time code entering the system through the SMPTE IN jack.



STOP
panel 2



RECORD
panel 2

Recording a sequence with SMPTE

Before beginning the recording, be sure the source of the SMPTE signal is connected to the Synclavier control unit as shown on the opposite page.

1. Activate SMPTE, select the correct SMPTE mode and set the desired offset time, as described in the previous section.
2. Press the STOP button to clear any previous functions.
3. If the SMPTE signal is recorded on video or tape, select the **repro** or **play** mode on the video recorder or tape recorder. Adjust the output level of the SMPTE track to equal or exceed the level at which it was recorded.
4. Select a timbre for recording.
5. Press the RECORD button.

The sequencer is ready to record when the correct SMPTE time is received.

6. Start the tape playing. If you have a Synclavier keyboard, the SMPTE offset time is shown in the upper half of the display window while the incoming time code is shown in the lower half.

When the incoming code matches the offset time, the sequencer begins recording.

Note: You cannot place overall loops on the sequence, since overall looping is incompatible with SMPTE. Use independent loops on individual tracks instead.

Recording a Direct-to-Disk track with SMPTE

Before beginning the recording, be sure the source of the SMPTE signal is connected to the SMPTE IN jack of the control unit.

1. Activate SMPTE, select the correct SMPTE mode and set the desired offset and display times.
2. If the SMPTE signal is recorded on video or tape, select the repro or play mode on the video recorder or tape recorder. Adjust the output level of the SMPTE track to equal or exceed the level at which it was recorded.
3. Set the recording parameters for track(s) on which you want to record.
4. Set the record Mode and Trigger switches on the Record Control panel and select the trigger times.
5. Click READY.
6. Click RECORD.

Recording does not begin until the appropriate SMPTE offset time is received.

7. Start the SMPTE source.

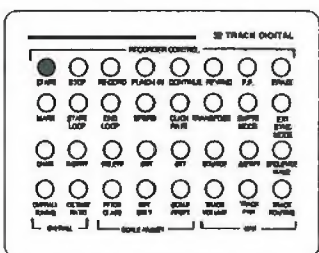
The recording starts and stops when the incoming time code matches the trigger times.

SYNCHRONIZATION AND TIME CONTROL									
Display time in SMPTE			Click OFF 120.00 Beats/Min			Sync Internal			
SMPTE	In	Drop Frame	30 fps	25 fps	24 fps	Beats/Meas	4	Speed	1.000
	Display	Drop Frame	30 fps	25 fps	24 fps	SMPTE Offs	00:00:00.00		
Footage Display		30 mm 16mm	30 fps	25 fps	24 fps	Footage Offs	0:00.0		

*Record Control panel of
the Audio Event Editor*

Playing back with SMPTE

When you play back a sequence while the SMPTE option is turned on, playback does not begin until the proper time code is received through the SMPTE IN jack.



START
panel 2

Playing back a sequence

Any sequence that has SMPTE parameters can be played back synchronized to the incoming time code from either the keyboard control panel or from the Sequence Editor.

1. Make sure the SMPTE option is turned on and the SMPTE mode selected for the sequence matches the format of the incoming signal.
2. Adjust the output level of the recorded SMPTE track to match or exceed the level at which it was recorded.
3. Press START on the keyboard control panel or click START on the Sequence Editor.

The sequence does not play. The system is waiting for the correct SMPTE time code to be received before starting.

4. Start the video or tape recorder.

When the incoming time code matches the offset time of the sequence, the sequencer starts to play.

Playing back Direct-to-Disk tracks and cues

Either Direct-to-Disk tracks recorded in Punch In (continuous recording) or cues placed in a sequence can be played back locked to time code from the Audio Event Editor.

1. Make sure the SMPTE option is turned on.
2. Set the track mode to Repro or Auto if you are playing back DTD tracks recorded in Punch In. Set the track mode to CuePB if you are playing back cues placed in a sequence.
3. Click START on the Sequencer Motion Control panel.

Playback does not begin until the correct SMPTE time code is received.

5. Start the SMPTE source.

When the incoming time code matches the start time of the tracks or sequence, playback begins.

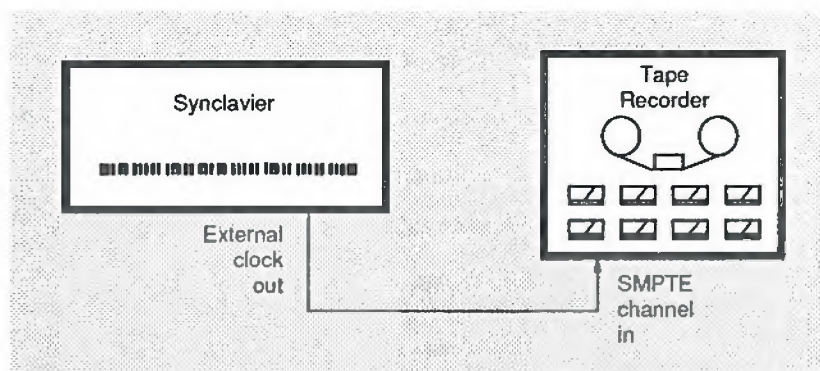
Generating SMPTE time code

You can generate time code in any of the four formats listed in the previous section. The SMPTE signal is sent through the EXTERNAL CLOCK OUT jack on the Synclavier control unit or the SMPTE OUT jack on the Direct-to-Disk control unit.

Recording a SMPTE signal

To record a SMPTE signal on tape, set up the control unit and the video or tape recorder as shown on the opposite page.

On a video tape, you record the SMPTE signal on the cue track. On an audio tape, record on an edge track (highest or lowest track number) if possible. Where track availability allows, leave a blank track between the SMPTE track and other recorded tracks to avoid crosstalk. Avoid recording percussive signals on tracks adjacent to the SMPTE track; crosstalk from the percussion signals may affect the SMPTE code.

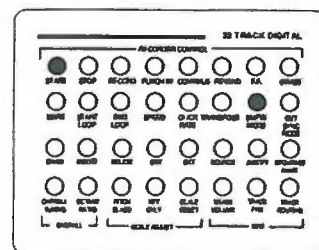


Recording a SMPTE stripe to tape from the keyboard control panel

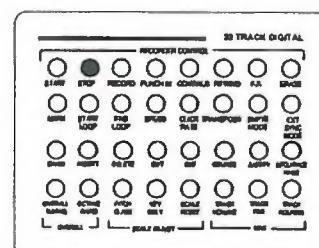
1. Activate SMPTE, select the desired time code format and dial in the desired offset time, as described in "Setting SMPTE parameters from the keyboard control panel" above.
2. Place the tape recorder in the input or record mode (metering the input level).
3. Press and hold the SMPTE MODE button while you press the START button.

The display window shows the SMPTE generator running. Except for the STOP button, all control panel buttons and keyboard keys are inactive while the generator is running.

4. Set the recording level on the tape recorder. On professional tape decks, a signal level of -10 dBv is recommended with SMPTE when synchronizing at normal speeds. On semi-pro machines (narrower track formats such as half-inch or quarter-inch eight-track) a -3 dBv level is recommended. If you anticipate playback at very slow speeds (for video spotting, for example), a higher signal level may be necessary to provide a better margin of error.
5. Press STOP on the keyboard control panel.
6. Start recording on the tape recorder.
7. Restart the SMPTE generator by holding down the SMPTE MODE button while pressing START, as before.
8. Record the SMPTE signal for a period of time equal to or greater than the duration of the sequence you intend to synchronize. When you have recorded enough SMPTE signal, press the STOP button.
9. Stop the tape recorder and rewind the tape.



START and SMPTE MODE
panel 2



STOP
panel 2

Generating SMPTE time code (con't)

Recording a SMPTE stripe to tape from the Audio Event Editor

1. Activate SMPTE, select the desired time code format and dial in the desired offset time, as described in "Setting SMPTE parameters from the Audio Event Editor" above.
2. Place the tape recorder in the input or record mode (metering the input level).
3. Click the GENERATE SMPTE button on the Synchronization and Time Control panel.

The SMPTE generator starts and time code is displayed at the bottom of the screen. Except for the STOP button, all motion controls and all other panel functions are inactive while the generator is running.

SYNCHRONIZATION AND TIME CONTROL

Display Time In	Measures:Beats	SMPTE Offset:	<input checked="" type="checkbox"/> 00:00:00:00.00	30 Frame	Drop Frame	25 Frame	74 Frame	
Synchronization:	MIDI In	Click Track	OFF 120.00 Beats/Min	Beats Per Measure:	4	Speed:	1.000	
Set Display Offset	Compute SMPTE offset	Compute Event Time	Generate SMPTE					

(continued next page)

Recording a SMPTE stripe to tape from the Audio Event Editor (con't)

4. Set the recording level on the tape recorder. On professional tape decks, a signal level of -10 dBvu is recommended with SMPTE when synchronizing at normal speeds. On semi-pro machines (narrower track formats such as half-inch or quarter-inch eight-track) a -3 dBvu level is recommended. If you anticipate playback at very slow speeds (for video spotting, for example), a higher signal level may be necessary to provide a better error margin.
5. Click the GENERATE SMPTE button again to stop generating SMPTE.
6. Start recording on the tape recorder.
7. Restart the SMPTE generator by clicking the GENERATE SMPTE button, as before.
8. Record the SMPTE signal for a period of time equal to or greater than the duration of the sequence you intend to synchronize. When you have recorded enough SMPTE signal, click the GENERATE SMPTE button again.
9. Stop the tape recorder and rewind the tape.